Monitoring of Surface Deformation in Northern Taiwan Using InSAR

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Monitoring of Surface Deformation in Northern Taiwan Using DInSAR and PSInSAR Techniques
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A Multi-temporal InSAR Method Incorporating both Persistent Scatterer and Small Baseline Approaches
Andrew Hooper
Introduction
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Methodology
- DInSAR
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Introduction
Geological framework

1. Chinshan Fault
2. Shanchiao Fault
3. Kanchiao Fault
4. Taipei Fault
5. Hsinchuang Fault
6. Nankang Fault
The phase difference between two images acquired at different times creates an interference pattern called an interferogram.
Limitation of DInSAR

Limitation of DInSAR (I)- Surface feature

Limitation of DInSAR (II)- Atmospheric effect
Limitation of DInSAR

Limitation of DInSAR (IV) - Time feature
**PSInSAR (Persistent Scatterer (PS) InSAR)**

The echoes sum to give one phase value for the pixel.

- **Distributed scatterer pixel**
- **Persistent scatterer pixel**
Processing flowchart for PSInSAR analysis. The main processes include: Raw data process, SAR image process, differential interferometry process, PS selecting, intersection of PS and phase extracting, phase unwrapping, DEM error correcting, atmospheric filtering.
PSInSAR

Time series of deformation interpolated spatially from the processed PS.

Location of Long Valley Caldera in California. The color of each PS represents the mean velocity in LOS.
Small baseline InSAR

Baseline plot. The triangle represents the master image used in the PS processing, circles represent the other images, and lines represent the SB interferograms formed.

Differential interferograms of the northern Taiwan area. White line: fault line. Blue line: administrative boundary.
(a) Stacked unwrapped result of the interferograms.
Red line: fault line
Blue line: administrative boundary
Points 1 ~ 9: leveling survey points

(b) Comparison between leveling measurement (white points linked by black line) achieved from 1992 to 2003 and DInSAR result (small red points) based on images acquired from 1993 to 2005.
1957~1973
40m of water table descent has been observed, at least 2m of land subsidence occurred in this period
from 1973
water table descending trend slow down
since 1981
water table began to ascend and land subsidence was almost ceased
Slant range displacement rate of the processed PSs in the northern Taiwan area. This result has been adjusted by using the base point of “Taiwan Vertical Datum 2001” in Keelung harbor as the control point. Warm colors represent land uplift and cold colors represent land subsidence in slant range direction.
Image pairs used for PSInSAR analysis.

Unwrapped phase of PS pixels of each images referenced to the master image.

Images from 22 November 2003 to 1 December 2007
Comparison between the leveling data and PSInSAR result along the northern coastal line (Profile A) and the northern bank of Tanshui River (Profile B).
Small baseline result represent the slight uplift in the Tatun volcanoes and the displacements along the Shanchiao and Chinshan Faults are large enough be observed.
DInSAR

The advantage of the DInSAR technique is that the surface deformation information can be directly extracted by using only two images acquired at different times.

The weakness of the DInSAR technique is that some atmospheric effects are believed to be still existed. The topography and covered vegetation reduce the coherence of radar images.

PSInSAR

The advantage of the PSInSAR technique considers only the stable scatterer, thus can reduce the noise ratio in radar image.

The weakness of the PSInSAR technique is the perpendicular baseline.
Small baseline

The advantage of the small baseline technique is that the baseline effect can be reduce.

The weakness of the small baseline technique is the amount of Persistent scatterer (PS) may be reduce.

Integrating these results, we observed conspicuous deformation events in northern Taiwan including: (1) the slight uplift in the Tatun volcanoes, the Linkou Tableland and the Taoyuan area; (2) the subsidence at the border of the Taipei basin; and (3) relative slight uplift rebound in the center of Taipei basin. (4) The displacements along the Shanchiao and Chinshan Faults are large enough to be observed.
Thank you